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DEPARTMENT OF THE INTERIOR

UNITED STATES BUREAU OF MINES
JOHN W. FINCH, DIRECTOR

INFORMATION CIRCULAR

# REPORT OF WORK OF THE MINING DIVISION, U. S. BUREAU OF MINES FOR CALENDAR YEAR 1936, AND PROGRAM FOR 1937

BY

CHAS. F. JACKSON

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## INFORMATION CIRCULAR

## DEPARTMENT OF THE INTERIOR - BUREAU OF MINES

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# REPORT OF WORK OF THE MINING DIVISION, U. S. BUREAU OF MINES, FOR CALENDAR YEAR 1936, AND PROGRAM FOR 1937[1]

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By Chas. F. Jackson[2]

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The work of the mining division is divided between seven sections, each in charge of a supervising engineer, as follows:

1. Metal-mining methods section, the supervising engineer of which is also supervising engineer of the Southwest Experiment Station at Tucson, Ariz.

2. Metal-mining research section.

3. Nonmetal mining section.

4. Coal-mining section.

5. Mine-ventilation section.

6. Mineral-industries survey section.

7. Electrical section.

The names of the sections indicate broadly the fields covered by each, and in the following pages the objectives and type of work of each section will be summarized briefly and the active problems listed. The work done during the calendar year 1936 will also be summarized.

## 1. Metal-Mining Methods Section

Problem Min. M. 1: Metal-Mining Methods in Western States. - For some years, the work of this section has been devoted largely to a study of mining methods, practices, and costs in the Western States in cooperation with the managers and other operating officials of the principal mines. The characteristics of the ore deposits and the nature of the ores, the mining methods and practices, and the operating costs (expressed both in dollars and in units of labor, materials, power, and supplies) at each mine have been recorded in accordance with an outline and published in the form of information circulars. The object was to provide a mass of comparable data covering a wide range of conditions upon which to base an analytical study of mining methods and practices from the operators' viewpoint. Durin 1936, the following publication was issued:

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[1] The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from U. S. Bureau of Mines Information Circular 6939."

[2] Chief engineer, Mining Division, U. S. Bureau of Mines.

Inf. Circ. 6880 - Mining Methods and Costs at the Park City Consolidated Mines Co., Park City, Utah. 13 pp.

In addition to the one published circular, the following manuscripts were prepared and now await publication:

Inf. Circ. ____ - Mining and Milling Methods at the Pilgrim Mine, Chloride, Ariz.

Inf. Circ. ____ - Mining Methods at the Carson Hill Mine, Calaveras County, Calif.

Inf. Circ. ____ - Mining and Milling Methods and Costs at the Golden Messenger Mine of the United Gold Mines Corporatio York, Mont.

This problem is a continuous one and it is planned, in addition to publishing reports from time to time on operations not previously describe to prepare supplements covering significant changes in practices at mines scribed in circulars issued some years ago.

Problem Min. M. 2 (Continuous): Metal-Mining Methods and Costs Summaries. - This problem embraces studies of the principal mining metho and different phases of mine operation, such as underground transportatio chute gates, ore pockets, sampling and estimation of ore deposits, shaft sinking, waste filling of stopes, sampling and exploration, placer mining methods and costs of equipping and developing prospects, leasing systems, drifting and crosscutting, aerial-tramway construction and operation, an the like. It also includes studies of the mining of different types of ore - gold mining, lead and zinc mining, etc. The studies are based to a large extent upon the data contained in circulars published under problem Min. M. 1, but include, also, special field investigations to round out these data and fill in the gaps. During 1936, the following publications in this series were issued:

Inf. Circ. 6898 - Costs of Trucking and Packing Ore in Western Gold-Mining Districts. 17 pp.

Inf. Circ. 6923 - Shaft Sinking with a Shot Drill, Idaho-Maryland Mine, Grass Valley, Calif. 10 pp.

In addition, the following manuscripts were completed and await publica-
on:

Inf. Circ. ____ - Design of Small Wooden Headframes.

Bull. ____ - Copper Mining in North America.

Inf. Circ. ____ - Aerial Tramways in the Metal-Mining Industry. Part I.

Active problems under Min. M. 2 are as follows:

Min. M. 2-b: Placer Mining of Gold.

Min. M. 2-c: Development, Equipment, and Operation of Small Gold Mines.

Min. M. 2-d: Aerial Tramways in the Metal-Mining Industry. Part II. Methods and Costs of Operation.

Min. M. 2-c: Mine Drainage and Pumping.

The broad objective of work under Min. M. 1 and Min. M. 2 is to acquaint
e operators and engineers generally with improved methods and practices de-
oped locally, to the end that mining technology be raised in this country
he highest possible state of efficiency. A number of specific instances
e been brought to our attention where decided improvements in methods and
s have been attained as a result of these publications.

Since members of the division staff have received many requests from
e operators for more of this type of publication, it may safely be inferred
t the desired results are being obtained.

Problem Min. M. 3 (Continuous): Milling Methods and Costs, Western
es. - This embraces studies of milling methods and costs and the prepara-
n for publication of manuscripts covering these studies at individual ore-
sing plants. The procedure and objectives are the same, with respect to
ling operations, as those under Min. M. 1 and Min. M. 2 are with respect
mining operations.

During 1936, one circular was published, Information Circular 6900,
ing and Milling Methods and Costs at the Yellow Aster Mine, Randsburg,
if. 21 pp.

In addition, the following manuscripts were completed and are ready
printing:

Inf. Circ. ____ - Mining and Milling Methods and Costs at the Pilgrim Mine, Chloride, Ariz.

Inf. Circ. ____ - Mining and Milling Methods and Costs at the Golden Messenger Mine of the United Gold Mines Corporation, York, Mont.

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Problem Min. M. 4: Milling Methods and Costs Summaries. - This proble embraces studies of special phases of mill operation, the milling of ores o different types, and related problems and the preparation of reports thereo They are based in part upon data contained in circulars under Min. M. 3 an partly upon special field investigation. During 1936, the following public tions were issued:

Inf. Circ. 6891 - Design and Operation of a 4-Ton-Per-Hour Gold and Silver Ore-Sampling Plant. 40 pp.

Inf. Circ. 6926 - Open Schedules for Gold and Silver Ores and Concentrates at Western Custom Smelters. 25 pp.

Problem Min. M. S (Continuous): Part of the Mineral Industries Surve Supplementing the Work of the Mineral Industries Survey Section. - This problem includes field surveys and preparation of reports for publication on mining and milling practices and costs in various western mining distri data on known ore occurrences therein; haulage, freight and ore-treatment costs; and generalized geological data. It includes, also, assistance to small-scale operators and prospectors who are obviously financially unable to employ competent technical advice. Such assistance is granted only upo request. In cases where it appears that the operator can afford to employ needed technical assistance, the engineers of the Bureau are able to recommend competent consultants, the practice being to give at least three names

Publications issued during 1936 were:

Inf. Circ. 6901 - Gold Mining and Milling in the Black Mountains, Western Mohave County, Ariz. 59 pp.

Inf. Circ. 6902 - Reconnaissance of Mining Districts in Pershing County, Nev. 57 pp.

Inf. Circ. 6905 - Gold Mining and Milling in the Black Canyon Area, Yavapai County, Ariz. 51 pp.

University of Nevada Bulletin, vol. 30, No. 4, Placer Mining in in Nevada, written by William O. Vanderburg, of the Mining Division, and published by the University of Nevada. 180 pp.

In addition, the following was completed and ready for publication:

Inf. Circ. ____ - Reconnaissance of Mining Districts in Mineral County, Nev.

Field work was finished and reports nearly completed in 1936 for the following publications:

Inf. Circ. ____ - Gold Mining in New Mexico.

Inf. Circ. ____ - Gold Mining and Milling Methods in the Tobacco
Root Mountains, Mont.

Inf. Circ. ____ - Mining and Milling in the Seardhlight and
Eldorado Districts, Clark County, Nev.

Inf. Circ. ____ - Mining and Milling in the Wickenburg Area,
Ariz.

During 1937, it is proposed to cover other mining districts and to ther field data for a bulletin on placer mining in Idaho in cooperation ith the Idaho State Bureau of Mines and the U. S. Geological Survey.

## 2. Metal-Mining-Research Section

The work of this section is of two different types - first, that coming der Problems Min. R. 1, Min. R. 2, Min. R. 3, and Min. R. 4, which are the me as Min. M. 1, Min. M. 2, Min. M. 3, and Min. M. 4, except that they ver studies of and reports on mining and milling operations in the Central d Eastern States; and, second, research in fundamental mining engineering oblems.

Publications issued during 1936 under the first general classification re as follows:

Problems Min. M. 1 and Min. M. 3:

Inf. Circ. 6914 - Mining and Milling Methods and Costs, Hog Mountain
Gold Mining & Milling Co., Alexander City, Ala. 23 pp.

Inf. Circ. 6908 - Underground Mill at the Doyle Mine, Shullsburg,
Wis. 4 pp.

Problem Min. R. 2-a: Applications of Compressed Air in Mining. - This dy was started in 1936 and has for its object correlation, discussion, d analyses of available information on different types of compressors; ansmission of compressed air; different applications of compressed air mining operations; advantages and disadvantages of compressed air comred to electrical, steam, and gas-engine drive for mining equipment; and e preparation of a bulletin on the subject. A study of the literature d special field investigations are involved.

Problem Min. R. 2-b: Steel Shop Practice at Metal Mines. - This problem o cover a study of steel-shop lay-outs, drill-steel sharpening and heateating practices, methods of handling steel, etc. During 1936 one publicaon was issued:

Inf. Circ. 6907 - Hot Milling of Rock-Drill Bits at the Mines of the
Vinegar Hill Zinc Co., Platteville, Wis. 2 pp.

Problem Min. R. 2-c: Signal Systems in Metal Mines. - This investigation contemplates gathering of data on installation, operating, and maintenance costs for different types of shaft signal systems, their relative dependability, the particular field of application for each type, and the preparation of a report covering the investigations. Considerable data wer gathered during 1936 but no publications have been issued as yet.

The second type of work of the research section embraces a number of different types of problems, as follows:

Problem Min. 5-5-a: Use of Detachable Rock Drill Bits. - This study co the gathering of field and shop data on performance and costs of drilling with detachable bits compared to standard bits forged on the steels; tests of detachable bits of different types and different steel compositions at the Mount Weather testing adit; analyses of data; study of adaptability of bits of different types and compositions to drilling different kinds of rocks; and preparation of reports for publication.

During the latter part of 1935 and 1936, about 35 metal mines where detachable bits were being employed were visited for the purpose of gathering operating data and for discussion of the subject with mine operators. Preliminary reports were published during 1936, as follows:

Inf. Circ. 6877 - Progress Report on Investigation of Detachable Rock-Drill Bits. 9 pp.

Inf. Circ. 6911 - Progress Report 2 on Investigation of Detachable Rock-Drill Bits. 20 pp.

In addition, Progress Report 3 was completed and awaits publication, and Progress Report 4 was about half finished.

Reports 1 to 4, inclusive, each comprise data on practices and costs at about 10 different mines. It is planned to summarize and analyze the data from all the mines later and from time to time publish additional reports on tests at Mount Weather as results are obtained that will contribut to the knowledge of the subject.

During 1936, arrangements were made with manufacturers of alloy steel and with bit manufacturers for making up alloy-steel bits and rods. A number of alloy bits were delivered and tested by our engineers for Rockwel hardness preliminary to making actual drilling tests at Mount Weather testi adit.

Problem Min. R-5-b: Determination of Stresses in Rocks by Use of Seismometers and Supersensitive Microphones. - The purpose of this study i to devise and conduct laboratory and field tests with apparatus by the use of which it is hoped we may be able to determine conditions leading to failure of rock and coal pillars and arches before ordinary indications, such as settlement, spalling, cracking, etc., are apparent. If apparatus

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this kind can be developed, it should assist materially in determining safe size of mine openings (rooms and stopes) and the minimum safe lar sizes in different mines or sections of the same mine, and also in solving roof-control problems and in forewarning against accidents m caving and falls of ground.

Preliminary experiments conducted during 1936 with the Bureau of Mines e of seismometer showed that both amplitude and frequency of induced rations in rocks under test varied with change of pressure, although the tests made do not indicate as yet any law regarding relationship of ration characteristics to pressure. It was found that the curves (pres- e against amplitude of vibration and pressure against frequency of vi- tion) probably vary with the kind of rock and with the arrangement of recording devices, but in every instance amplitude and frequency curves ak at about the same pressure in each test, which may indicate a critical nt in condition of the rock. Tests are to be continued from time to e during 1937.

Problem Min. R. 6: Operation of Mount Weather (Va.) Testing Adit. - s provides for driving an adit and other workings therefrom on Government- ed land at Mount Weather, Va., to provide a testing laboratory in which to estigate a number of important fundamental mining problems under simulated e-scale conditions but where interfering variables can be eliminated or trolled. The rock formation consists of basaltic lava flows, which in ces are largely altered to epidote. The unaltered lava is very hard, con- ns 10 percent and upward of free silica, and can be drilled at the rate about 6 inches per minute with sharp steel and 3-1/2-inch drifter machines rating on 90 to 100 pounds air pressure.

he altered rock is softer (some is very soft), and some of the ground seamed and shattered. A variety of drilling conditions is therefore pre- ted, which is desirable for test work.

Work was begun late in September 1936. By the end of the year the site been cleared, roads cleared and repaired, a 210-foot air compressor in- led and properly housed, an office set up in an old farmhouse close to adit, rock-drilling equipment assembled and placed in service, pipe lines , and 100 feet of 7- by 8-foot adit driven, timbered, and tracked, all he expenditure of a very small amount of money.

t is planned to conduct experimental work with other divisions of the nologic Branch of the Bureau and with the Health and Safety Branch.

roblems now active and contemplated for 1937 include the following:

roblem Min. R. 6-a: Use of Various Wetting Agents in Allaying Rock t in Drilling and Blasting Operations. - This is to be conducted in co- tion with the staffs of the Metallurgical Division and the Health and ety Branch.

Problem Min. R. 6-b: Investigation of Various Gases Liberated in Blasting under Controlled Mine Conditions. - Work is to be conducted in cooperation with the Explosives Division.

Problem Min. R. 6-c: Study of Fundamental Mine-Ventilation Problems. - This comprises further studies of friction factors at bends in mine airways; efficiency of compressed-air injectors and ejectors in mine ventilation; cooling and dust-removing effects of ventilating currents of different velocities and humidities, in cooperation with the mine-ventilation section of the Mining Division.

Problem Min. R. 6-d: Effect of Bit Sharpness on Dustiness during Wet Drilling. - This work proceeds in cooperation with the Health and Safety Branch.

A series of wet-drilling tests was run in December 1936, which, while not conclusive, revealed some significant information: 1. Sharp bits produced more dust per unit of time and per foot drilled than dull bits. This is probably because the rate of drilling was slower and the diameter of hol smaller with the dull bits, so that with water flowing at a constant rate through the steel and into the drill hole, the amount of water per cubic inch of material removed was two to three times as great with the dull stee 2. The cuttings were finer with the dull bits. 3. The rate of dust production in collaring and drilling the first foot or two of hole was several times that in drilling the rest of the hole. These facts are significant, as they indicate the efficiency of water thoroughly mixed with cuttings before they leave the hole in allaying dust.

An inside caliper was designed and constructed for measuring diameters of rock-drill holes. Additional tests are contemplated, in which the exhaust air from the drill will be piped outside the adit; the air entering the drill and that exhausted will be measured, thus giving by difference the amount of air passing through the drill steel; the volume of rock removed during each run of the drill will be computed from measurements of th depth and diameter of the hole, and the amount of water used in drilling each run will be measured.

## 3. Nonmetal-Mining Section

The nonmetal-mining section concerns itself with investigations of the mining and preparation of industrial minerals and the publication of repor thereon. The work is designed to cover the field of nonmetal mining in the same manner that the metal-mining methods and metal-mining research sectio cover the metallic mining field.

Problem Min. N. 1 (Continuous): Methods and Costs of Mining and Preparation of Nonmetallic Minerals. - This problem includes studies of mining and quarrying and preparation of nonmetallic minerals at individual pits and plants and preparation of manuscript reports thereon. The object is to aid, through dissemination of information on details of practice, improvement in technology, efficiency, and elimination of waste. Publicatio during 1936 were as follows:

Inf. Circ. 6885 - Mining and Grinding Methods and Costs at the Claycraft Co. Shale Pit, Taylor Station, Columbus, Ohio. 10 pp.

Inf. Circ. 6887 - Mining and Grinding Methods and Costs at the L. W. Camp Co. Shale Pit, Akron, Ohio. 10 pp.

Inf. Circ. 6889 - Mining and Grinding Methods and Costs at the Camp Bro. Co. Shale Pit, Mogadore, Ohio. 11 pp.

Inf. Circ. 6910 - Mining, Treatment, Methods, and Costs at the Gifford Hill & Co. Sand and Gravel Plant at Hoot Spur near Texarkana, Tex. 11 pp.

Inf. Circ. 6912 - Quarrying and Crushing Methods and Costs at the Avon Mountain Trap-Rock Quarry of the Atlas Sand, Gravel & Stone Co., West Hartford, Conn. 7 pp.

Inf. Circ. 6913 - Mining and Grinding Methods and Costs at the Clay City Pipe Co. Clay Mine, Uhrichsville, Ohio. 16 pp.

Inf. Circ. 6920 - Quarrying and Crushing Methods and Costs at the Plainville, Conn., Trap-Rock Quarry of the New Haven Trap Rock Co. 23 pp.

Inf. Circ. 6921 - Mining and Grinding Methods and Costs at the Dennison Sewer Pipe Co. Clay Mine, Dennison, Ohio. 16 pp.

Inf. Circ. 6929 - Mining and Grinding Methods and Costs at the Evans Pipe Co. Clay Mine, Uhrichsville, Ohio. 18 pp.

In addition, the following reports were completed and ready for rinting:

Inf. Circ. ____ - Mining and Crushing Methods and Costs at the Kentucky-Tennessee Clay Co. Pit, Mayfield, Ky.

Inf. Circ. ____ - Mining and Milling Methods and Costs at the Glass Sand Plant of P. J. Weisel, Inc., Corona, Calif.

Min. N. 2: Methods and Costs of Mining and Preparation of Nonmetallic inerals, Summaries. - This problem comprises investigations and reports marizing special phases of mining and preparation of nonmetallic minerals; e different nonmetallic minerals and commodities; the different operations tering into mining and preparation; and preparation of special products erived from nonmetallic minerals. These are based in part upon studies under n. N. 1 and in part upon special field investigations. Publications issued ring 1936 were:

Inf. Circ. 6875 - Sand and Gravel Excavation - Part 5: Motor-Truck Haulage, Pumps and Pipe Lines, Barges and Towboats, Aerial Trams. 74 pp.

Inf. Circ. 6879 - Sand and Gravel Excavation. - Part 6. Mining Methods. 46 pp.

Parts 1 to 4, inclusive, were issued during the calendar year 1935.

During 1936, 26 mineral-wool plants were studied, and data were gathered as a basis for a report to be prepared on the subject of mineral wool.

Another phase of the work of this section is in fundamental engineering research under problem Min. N. 3, Research in Mining and Quarrying Non metallic Minerals.

Min. N. 3-a: Relation Between Size Gradation of Quarry-Run and Prim Crusher Products. - This study is being conducted to determine the screen sizes produced by primary crushers of various types with rocks of differen kinds and various feed sizes. Little is known on this subject, though it is one of importance in certain nonmetallic industries.

Library research in 1936 was followed by screen-sizing tests at a number of quarries; the data were compiled, and further necessary tests were planned for continuance of the investigation during 1937.

Min. N. 3-b: Earth and Air Vibrations Caused by Blasting in Quarrie and Mines. - The purpose of this work is to determine, by the use of seis graphs and recording apparatus developed by the Bureau of Mines staff, the characteristics (amplitude, frequency, and rate of propagation) of vibrat waves produced by blasting, both fundamentally and in relation to the tra mitting media, and to their effects upon artificial structures. The Bureau apparatus measures the amplitude of vibrations in ten-thousandths an inch.

During 1936, a complete field outfit was assembled in a specially co structed truck. Observations were made in 19 quarries situated in a num of the Eastern and Southern States on the vibrations caused by shots rang from 42 to 20,000 pounds of explosive per shot. The resulting data were piled and correlated, and confidential reports were sent to a number of cooperating quarry companies concerned. As a result of this work, consid new information has been gained concerning the characteristics of earth tions caused by blasting operations, and the influence upon them of struc changes in the ground, and field technique was developed. It has been for example, that loose overburden vibrates as a mass at its own frequenc and that the vibrations of the mass may differ considerably in frequency, amplitude, and speed of propagation from those in the underlying solid rock strata. Considerable work was done on the calibration of recording instruments, and a number of improvements were made that will make for still greater accuracy of future measurements.

One publication was issued, Report of Investigations 3319 - Earth Vi- ations Caused by Quarry Blasting. 19 pp.

During 1937, it is planned to carry the work into its next stage - ie study of the effects of earth vibrations on artificial structures, relation- ip of vibrations produced by blasting to those of the structures themselves, d the like.

## 4. Coal-Mining Section

The work of the coal-mining section, which was reestablished late in 35, is designed to cover the coal-mining field in much the same manner and th the same general objectives as the metal- and nonmetal-mining sections their particular fields. Although the present staff of two engineers is adequate to handle a subject as large and varied as coal mining, the re- lts of the work in 1936 were not without value.

Problem Min. C. 1: Coal-Mining Methods and Costs. - Studies are made der this problem of coal-mining methods, practices, and costs at individual nes or groups of mines, and reports thereon are prepared for publication. e purpose is also to acquaint coal operators generally with improvements practice developed locally with a view to increasing operating efficiency d promoting safety and conservation in mining.

Published during 1936 were:

Inf. Circ. 6893 - Long-Wall Mining Methods in Some Mines of the Middle Western States. 62 pp.

Preparation of this circular involved visits to 12 mines, the study the methods and practices employed, and compilation of data thereon.

Inf. Circ. 6928 - Mining Methods Used in the Grundy Coal Field of Buchanan County, Va. 43 pp.

Nine mines in this field were visited and studied, and operating data ereon were compiled.

Min. C. 2: Coal-Mining Methods and Costs - Summaries. - This problem volves studies and preparation of reports for publication dealing with ecial phases of coal mining.

Min. C. 2-a: Shaft and Slope-Bottom Lay-Outs at Coal Mines. - Studies re completed and ready for publication. Field work involved visits to and dies of operations and data at 21 mines. The lay-outs described are il- strated by 14 figures.

Min. C. 2-b: Field work was completed and manuscript was 75 percent eted for a circular on "Strip Mining of Bituminous Coal." A large number strip-coal operations were studied in the field and data compiled, together h data supplied by manufacturers of strip-mine equipment.

Min. C. 2-f: The first investigation to be undertaken in 1937 embraces a study of concentrated multiple-shift mechanized mining.

Other investigations planned are as follows:

Min. C. 2-a: Locomotive vs. Truck Haulage in Strip-Coal Mining.

Min. C. 2-d: Cutter Bits. - The object of this study is to gather data in the field on coal-cutter bits of different types and compositions, their first cost, cost of sharpening and heat treatment, the particular fields of adaptability of each type, and relative costs of cutting coal.

Min. C. 2-e: Underground Haulage in Coal Mines. - The purpose of this investigation is to gather data on and to study in the field different haulage systems, haulage equipment, methods of operation, and operating performance and costs and to prepare reports on the investigations for publication.

## 5. Mine-Ventilation Section

This section has been engaged for some years in a study of mine-ventilation problems, mine-ventilation surveys, the determination of ventilation factors, and the like. The work has covered both coal and metal mining. During 1936, most of the year was spent on a study of the origin of mine fires in the anthracite region of Pennsylvania. To give a better idea of the work of the section, a number of the principal publications issued in preceding years are listed below:

Bull. 285 - Coal-Mine Ventilation Factors. 1929. 106 pp., 47 figs., 39 tables.

Bull. 330 - Ventilation of the Large Copper Mines of Ariz. 1931. 145 pp., 42 figs., 17 tables.

T. P. 516 - Natural Ventilation of Michigan Copper Mines. 1932. 40 pp., 5 figs., 6 tables.

Bull. 385 - Engineering Factors in the Ventilation of Metal Mines. 1935. 196 pp., 68 figs., 4 tables.

Inf. Circ. 6382 - Mine Ventilation in the Coeur d'Alene District, Idaho. 1931. 37 pp., 5 figs.

Inf. Circ. 6585 - Economic Size of Metal-Mine Airways. 1932. 21 pp., 4 figs.

Inf. Circ. 6663 - Pressure Losses Due to Bends and Area Changes in Mine Airways. 1932. 34 pp., 12 figs., 1 table.

The active problems of this section are as follows:

Min. V. 1 (Continuous): Mine-Ventilation Surveys. - This study includes an investigation of field conditions at individual mines, confidential reports and recommendations to operators, and preparation of reports on mine-ventilation methods and systems at individual mines or groups of mines for publication.

During 1936, a ventilation survey of a large mine in Idaho was made at the request of the operating company, and a confidential report made thereon. At the request of a large company in Utah, a study was conducted and recommendations made for the ventilation of a proposed large vehicular tunnel.

Min. V. 2 (Continuous): Mine-Ventilation Summaries. - This involves preparation of papers for publication on various phases of mine ventilation.

Min. V. 3 (Continuous): Mine-Ventilation Research. - The investigation includes study and determination of fundamental factors in connection with mine ventilation and of special problems.

During 1936, Report of Investigations 3298, Charts for Determining the Performance of Centrifugal Fans, was published. This contained 30 pages of text, 35 figures (charts, curves, etc.), and fundamental formulas.

Min. V. 3-a: Study of Origin of Mine Fires in the Anthracite Mines of Pennsylvania. - The purpose of this study is to determine from mine records of past and present mine fires, a study of mine atmospheres, coal composition, ventilating conditions, etc., and the origin of mine fires in this region. This is a cooperative investigation participated in by the Mining, Explosives and the Coal Divisions, the Health and Safety Branch of the Bureau, and one of the largest producing companies in the region.

During 1936, records of about 170 mine fires were studied, underground conditions were investigated, and numerous discussions were held with operating officials at the mines. A resume of the work done up to November 27, 1936, was prepared, which covered various phases of the investigation, as follows: A. Abstract of literature on mine fires. B. Survey and investigation of mine-fire records and tracing of probable cause of each fire, methods used in fighting fires, analyses of mine-fire atmospheres, analyses of coal and inflammable materials found underground (Coal Division), present status of mine fires, influence of mining methods, and ventilation on fires. C. Procedures for preventing fires. D. Methods of extinguishing fires.

At the end of the year, the results of the investigations to date were being tabulated and correlated in preparation for a preliminary report to the cooperating company and as a basis for continuation of the investigation.

Min. V. 4 (Continuous): Air-Conditioning of Mines. - This problem includes study of air-conditioning principles, methods, and practices; of air-conditioning apparatus with reference to its application to air-conditioning in mines; and of mine atmospheres in individual mines as they relate to need for conditioning.

During 1936, a study was made in a large copper mine in Arizona at the request of the operating company, and a confidential report was rendered.

## 6. Mineral-Industries Survey Section

This section was established to carry on an investigation provided for in the Interior Department appropriation bill for the fiscal year 1936 and continued in the 1937 bill. This bill provided for a "Mineral Inventory and Technical Aid to Small Operators." Because the metal-mining methods section was already well-organized, and because it was desired to cover the large field more rapidly, the work has so far been carried on jointly by that section and the mineral-industries survey section. Publications issued during 1936 as a result of the work of the former under Problem Min. M. S. have already been listed. These describe districts in which most of the mining operations are small and widely scattered, whereas the work of the mineral-industries survey section has comprised an intensive study of districts restricted in area, in which there are one or more outstanding mining operations or recent important new discoveries.

During the year, publications prepared by the section were as follows:

Inf. Circ. 6876 - Mineral Industries Survey of the United States. - Idaho, Shoshone County, Coeur d'Alene District. The Silver Belt and the Sunshine Mine of the Coeur d'Alene District. 16 pp., 6 figs.

Inf. Circ. 6931 - Mineral Industries Survey of the United States: California, Kern County, Mojave District - The Golden Queen and Other Mines of the Mojave District California. 42 pp., 13 figs.

Several months were spent in the southern Mother Lode area, Calaveras Tuolumne, and Calaveras Counties, California. The 1937 field season will gin with a return to this area for the purpose of completing the survey thereof and of a report for publication.

## 7. Electrical Section

This section was transferred to the Mining Division on July 1, 1936. Its work comprises principally the testing of electrically operated mine equipment of various types, flame safety lamps, gas detectors, and shot-firing devices intended for use in gassy coal mines. The work usually includes five phases for each type of equipment and apparatus, viz., (1) pre schedule work for ascertaining facts upon which to base a schedule; (2) preparation of a schedule; (3) testing apparatus under schedule requirements; (4) field investigations to check approved apparatus; (5) other investigative work closely allied with work under the schedule. Each sche cludes general specifications covering construction, materials of construction, general requirements necessary for approval by the Bureau, and describes the nature of inspections and tests to which equipment submitted for proval will be subjected. Tests are conducted at the Experimental mine, ceton, Pa., and in specially constructed galleries at the Pittsburgh (Pa.) periment Station. In these galleries, tests are made with the apparatus rounded by explosive mixtures containing varying percentages of Pittsrgh natural gas and air (simulating natural mine mixtures). The work is ne under 12 problem numbers, as follows:

Min. P.E.L. 1: Investigations of Electrically Operated Coal-Cutting ipment for Permissibility. (Sched. 2-C.)

Min. P.E.L. 2: Investigation of Electrically Operated Loading Machines r Permissibility. (Sched. 2-C.)

Min. P.E.L. 3: Investigation of Storage-Battery Locomotives and Power cks for Permissibility. (Sched. 2-C.)

Min. P.E.L. 4: Investigation of Miscellaneous Electrically Operated tfits for Permissibility. (Sched. 2-C.)

Min. P.E.L. 5: Investigation of Electrical Accessories, Such as Motors, ntrollers, etc., for Suitability and Explosion-Proof Qualities. (Sched. 2-C.)

Min. P.E.L. 6: Investigation of Trailing Cables. (Sched. 2-C.)

Min. P.E.L. 7: Investigating Mine Telephones and Other Signaling ipment for Permissibility. (Sched. 9-A.)

Min. P.E.L. 8: Investigation of Portable Electric Lamps for Permissility. (Sched. 6-B, 10-B, and 11.)

Min. P.E.L. 9: Investigation of Flame Safety Lamps for Permissibility. hed. 7-C.)

Min. P.E.L. 10: Investigation of Gas Detectors for Permissibility. hed. 8-B.)

Min. P.E.L. 11: Investigation of Electric Type Shot-Firing Devices for missibility. (Sched. 12-A.)

Min. P.E.L. 12: Miscellaneous. Safety studies other than those aldy listed under schedules bearing on the safe application of electricity ines.

The following publications were issued during the last half of 1936:

R. I. 3309 - Permissible Electrically Operated Air Compressors.
18 pp.

R. I. 3312 - The Improved Permissible Flame Safety Lamp. 10 pp.

Inf. Circ. 6894 - Electrical Viewpoint in a Complete Safety Survey of a Coal Mine. 18 pp.

Inf. Circ. 6904 - Milestones in Mine-Safety Legislation. 12 pp.

Inf. Circ. 6919 - Some Suggestions on the Prevention of Electrical Accidents in Coal Mines. 14 pp.

Inf. Circ. 6922 - Some Suggestions on the Safe Handling of Electric-Shovel Trailing Cables in Open-Pit Mines. 10 pp.

In addition, the following manuscripts were completed and ready for printing.

Report of Investigations 3327 - Behavior of Flame Safety Lamps in Mine Atmospheres Deficient in Oxygen. 6 pp.

Inf. Circ. ____ - Bureau of Mines Apparatus for Demonstrating Electrical Ignition of Mine Gas.

Schedule 16-A, Multiple-Shot Blasting Units, Requirements for Permissibility Tests Made, and Fees Charged, was drawn up and ready for submittal to the Secretary of the Interior for his approval.

From July 1 to December 31, 1936, 686 explosion tests were made, 13 ne approvals of equipment were granted, and 34 extensions of approval were issued to allow for changes in design and construction of equipment previously approved. This involved a large amount of work for examination of specifications and drawings and in connection with miscellaneous investigations.

A number of field inspections were made during the period, and demonstrations of the ignition of mine gas by electrical means in the exhibit room at Pittsburgh were witnessed by 350 visitors.